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other leaves, the author takes up the discussion of these and numerous related phenomena. He sees in them a trans-location of characters, that is, the transfer of characters from one structure to other structures, which latter may be further along in the ontogenetic line, or not so far along, or may belong to the alternative generation, or may be morphologically non-equivalent to the structures from which the transferred characters are borrowed. This transposition of characters he terms homoeosis, and in a paper of nearly forty pages illustrates and expands the principle with much force, and with convincing logic. Having established to his own satisfaction, at least, the doctrine of homoeosis, he is prepared to deduce certain conclusions as follows: "The study of homoeosis must somewhat increase the caution with which we use deviations from the normal as aids to morphological interpretation," a statement to which we fancy there will be little objection by any one, and which, it is to be hoped, will be taken to heart by morphologists and descriptive botanists the world over. It becomes evident that "relationship" may have a very different meaning when once we are aware of the facts of homoeosis, such as these which Professor Leavitt has so forcefully brought out in this paper. This service alone to morphology should justify the doctrine of homoeosis. His second conclusion that homoeosis has played some part in the evolution of plants will meet with little opposition. Lastly the author holds that the idea of homoeosis unites for descriptive purposes a great number of facts of ontogenesis which possess a considerable prospective value in connection with the effort to reach a correct mechanical interpretation of development.

CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

PALEOGEOGRAPHY OF NORTH AMERICA¹

FEW articles of greater general interest have appeared in the *Bulletin of the Geological Society* in recent years than this. The paper

¹ Charles Schuchert, *Bull. Geol. Soc. Am.*, Vol. XX., pp. 427-606, Pls. 46-101, 1910.

may be divided into two parts—(a) an introductory portion dealing with methods, criteria and principles of paleogeography, and (b) the sequence of events in North America.

The author emphasizes the paleontologic method as of first importance. The distribution of seas is to be inferred from the distribution of faunas. The faunas are kept apart by barriers, of which the most important are land barriers. The local effect of currents in which there are differences of salinity or temperature is recognized, but the author thinks this can not be appealed to as an explanation of most faunal differences of the past. The physiographic testimony furnished by the sediments themselves is recognized as having a modicum of value, which in some kinds of deposits rises to first importance; but in general the usefulness of such data is not regarded as large. The important diastrophic events of geologic history are used to divide the course of time into eras and periods, and it is also pointed out that minor oscillations are often responsible for individual formations.

Following the views of Suess, Willis and others, Schuchert regards the continent as a mosaic of positive and negative elements; that is to say, regions which have shown a tendency to stand out of water as against regions which have been subject to repeated submergences. The location and general outline of these elements as conceived by the author are represented on two maps.

The commendable caution of Suess is followed in speaking of geographic changes not as uplifts and subsidences, but as "positive and negative displacements of the strand line," or as emergences and transgressions. The emergences are ascribed to periodic subsidence of the ocean bottom, causing the epicontinental seas to be drawn off into the ocean basins. The transgressions, or advances, of the sea, are thought to be due to one or more of several causes: (a) the attraction of the sea by bold shore mountains, (b) the down warping of the continent into geosynclines, thus forming long trough-like seas, (c) the displacement of the sea level by the filling up

of the sea bottom as a necessary complement of erosion, and (*d*) the settling back of the continents in relaxation after periods of folding.

Following this discussion of principles the author gives a list of the chief strand line displacements with interesting although avowedly crude estimates as to the percentage of the continental plateau submerged at each stage. A graphic presentation of the same conclusions is given in the form of curves on plate 101 at the end of the paper. Barrell contributes a theoretical inquiry as to the effect which radial shortening would have on the rate of the earth's rotation, and on the degree to which a given increase in that rate would cause a heaping of the oceanic waters in the equatorial regions during times of orogenic activity. He finds reason to think that there would be a bulging of nearly 100 feet for each mile of radial shortening, which would tend to draw down the waters in the polar and temperate regions, to keep it stationary in latitude 35° and to cause a rise of the sea level in the tropics.

The second and much larger part of the paper contains a systematic account of the distribution and migrations of faunas, the geographic changes, and in some measure the nature of the climate and topography during the periods from the Cambrian to the Tertiary. This is illustrated by fifty maps showing the author's interpretation of the geography at each of many stages. To give a summary of this part would not be possible in a review, as it would almost necessitate a rehearsing of the original paper, which is itself much condensed. The most important general fact to be noted is the radical rearrangement of the geologic time table, which is given, in comparison with the current classification, as follows.

From this brief description it is plain that Mr. Schuchert's paper is one of first importance to the student of historical geology. It will be most highly valued as an up-to-date synopsis of the sequence of strata with their contained faunas from the base of the Paleozoic to the Tertiary period, and it will serve

as a hand-book of information for many a stratigrapher whose opportunities and experience have necessarily been less extensive than the author's.

THE NEW GEOLOGIC TIME TABLE			
	Old Classification.	New Classification.	
Paleozoic	Cambrian..... Ordovician or Lower Silurian Siluric..... Devonic..... Mississippian or Sub-Carboniferous..... Pennsylvanian..... Permian..... 	{ Georgic..... Acadie..... Ozarkic or Cambrian..... { Canadic..... Ordovicic..... Cincinnati..... Siluric..... Devonic..... { Mississippi..... Tennessee..... Pennsylvanic..... Permian..... 	Paleozoic.
Mesozoic	Triassic..... Jurassic..... Cretaceous..... 	Triassic-Jurassic { Comanchic..... Cretacic..... 	Mesozoic.
Tertiary or Cenozoic.	Eocene..... Oligocene..... Miocene..... Pliocene..... Pleistocene..... 	Eogenie..... Neogenie..... 	Neozoic.

Any one who has attempted the construction of paleogeographic maps knows the uncertainties with which the work is beset and the impossibility sometimes of knowing just where a particular shore line should be drawn. Under these circumstances it requires courage to put one's many doubtful views in the unchangeable record form of a map, and Mr. Schuchert is to be commended for what he has done in this way and for his interesting table of strand line displacements mentioned above. The imperfection of these is distinctly recognized in the author's introductory remarks and the aid of other students of the subject is solicited by him in making the maps agree with the progress of future discoveries. Doubtless many readers of the paper will, like the reviewer, be disposed to take issue with Mr. Schuchert on many matters of detail, but these are hardly within the province of a review.

The radical changes in the geologic time scale will probably arouse more differences of opinion than any other single feature of the article. It may be asked first whether each of

these changes is justified, and in the second place, whether they are likely to be accepted. Like other innovations, these will have to be tried out by the test of time and usage. It may be suggested in this connection that, if the Cambrian and Ordovician are to be bracketed as an era, the Pennsylvanian and Permian should also be set off by themselves for reasons which are well brought out by Mr. Schuchert's own discussion of these periods. To the reviewer it appears even more just that the Mesozoic era should be divided into two, the line of separation being marked by the intense and widespread Sierran disturbance. To be consistent in having periods based on diastrophic movements, the author should also combine the late Devonian with the Mississippian as one period,—a procedure which is sanctioned in effect on page 493, where it is said ". . . the diastrophism at the conclusion of the Devonian does not appear to have been marked in character. . . . In this instance the life record is thought to have greater value than the physical one in separating the Devonian from the Mississippian, but should the principle of diastrophism be the sole guide, then these two periods seemingly must be combined into one."

A study of the paper brings out the fact that the author has worked largely from the point of view of the paleontologist, excluding in large measure the data of other sides of geology. Indeed, this may be inferred directly from the author's own paragraphs on methods. On page 525 it is remarked that "these maps . . . are still inadequate, as far as presenting a final . . . geographic distribution of the various faunas is concerned." In other words the maps are really faunal maps rather than strictly geographic. That is to say, they show the distribution of fossils rather than of land and sea. Perhaps the author will contend that these are one and the same, but it is quite certain that others will dissent from this view and with much to be said on their side. In the reviewer's judgment, valuable information can be drawn from certain sources of which Mr. Schuchert appears to have availed himself only in small

measure, namely, the character and changes in the structure and composition of the sediments and the relations of conformity and unconformity between them. For example, the author excludes the interior sea from the Utah-Montana region at various times in the Paleozoic era, because the necessary faunas have not been found; in the face, however, of the fact that in many places an unbroken sequence of marine deposits has been found ranging from middle Cambrian to Mississippian. Many stratigraphers will not agree that the failure to find a fauna in a given section proves the existence of a "break" or "stratigraphic hiatus," much less a "disconformity." If the section is completely exposed and *if there is no physical evidence of an unconformity* it would seem that the burden of proof rests upon any one who doubts that sedimentation was continuous during the periods in question, whether or not the faunas are present.

A reading of the paper gives the impression that the author recognizes only two important factors which cause differences in faunas, *i. e.*, time and geographic isolation; in other words, that the Cambrian and Ordovician faunas of New York are unlike because one is much later than the other, while the Cambrian faunas of New York and Utah are dissimilar because they lived in marine provinces between which migration was impossible. It is occasionally admitted in the paper, however, and is generally recognized by biologists, that a third factor is operative—the environmental or edaphic factor. That the author is aware of this is indicated by the statement on page 589: "The wide difference between the Cretaceous of Mexico and that of the United States may be due in part to the decided limestone facies of the former region. . . ." But in most other instances where this factor might well come into play it seems to have been left out of consideration. Thus on page 550 it is remarked that the "wonderful Burlington crinoid fauna" is unknown "in the western sea." Since crinoids prefer certain environmental conditions and have by no means a uniform distribution on the modern

sea bottom, may not the edaphic factor help to explain the observed distribution, particularly since the dark Mississippian limestones of Utah and Montana are notably unlike the contemporaneous rocks of Iowa?

The lack of evidence on debatable points throughout the paper is a constant source of disappointment to the reader. Thus on page 454 it would be interesting to know what leads the author to suggest central California as the site of an inlet from the Pacific Ocean rather than some other part of the coast. The Paleozoic rocks are so highly metamorphosed or so deeply buried from Mexico to Alaska that only here and there (as in northern California and Oregon) are they clearly recognizable, and to the average geologist there seems to be no ground for choosing any particular spot for the purpose indicated. This deficiency is probably one which the author could not easily prevent. It is to be remembered that the subject is over-large to cover adequately in so brief a space. It may be hoped that Mr. Schuchert will soon find time to prepare a volume or volumes under the same heading, in which he will give the desired facts which support his views.

Two things will tend to detract from the confidence with which this important and otherwise impressive paper will be received by geologists in general. One is the nonchalant way in which questions of a complex nature are dismissed as if they were matters of established belief. For example, on page 490 one finds the implication that the origin of dolomite is a matter of common knowledge whereas it is still an unsolved riddle to keen students of the subject. Again on page 447 is the statement, "Oolites are formed in the littoral region of seas between tides. . . ." This may explain some oolites, but several other explanations have been offered and it can not be truthfully said that the subject of the origin of oolites is yet understood.

The second and more serious defect is the assertive and dogmatic form in which many a debatable matter is presented. Examples of this are abundant throughout the paper, but the following will illustrate: (page 453) "Its

syncline (Rocky Mountain sea) was due to thrusting of the Pacific mass. . . ." There is still much difference of opinion among the best students of the subject as to just what causes the warping of land surfaces. (Page 459) "Throughout the Paleozoic the northern Atlantic waters were separated from the southern Atlantic by the great continent Gondwana, uniting Africa and South America across the medial region of the present Atlantic. It is, therefore, not correct to speak of the northern Atlantic until the present form of this ocean has been attained. . . ." The existence of the Afro-American land bridge, although indicated by a considerable mass of evidence, is denied by many whose opinions are worth considering. (Page 495) "There was no Cordilleran sea of this time" (late Mississippian). In this case the unequivocal assertion of the author can be as positively refuted since a rich Kaskaskia fauna was discovered last year in the Wasatch Mountains of Utah.

In conclusion, and after offering these criticisms, the reviewer desires to repeat that the paper is a storehouse of information and a large contribution to the subject—the fruit of many years of careful study by a man well qualified as a paleontologist and blessed with unusual opportunities in the way of facilities and associations. Even so soon after its appearance it is plain that the paper is stimulating interest in the relatively new and still plastic science of paleogeography, in which much must be accomplished before firm foundations can be reached.

ELIOT BLACKWELDER
UNIVERSITY OF WISCONSIN,
April 25, 1910

SPECIAL ARTICLES
WEBBER'S "BROWN FUNGUS" OF THE CITRUS
WHITEFLY (*ÆGERITA WEBBERI* N. SP.)

H. J. WEBBER discovered this fungus in 1896 growing parasitically upon the citrus whitefly at Manatee, Fla. He described in detail the sterile form of the fungus.¹ This

¹ U. S. Dept. of Agr., Div. of Veg. Phys. and Path., Bul. 13, 27-30, 1897.